An in-depth look at scientific solutions to a real-world problem

Wildlife and Highway Management

Lesson 3: How Can We Determine if We Have Been Successful?

LESSON OVERVIEW

Students read about an experiment designed to collect data on which animals use wildlife underpasses and how they use them. The students use this information to design a research question that they could answer with the collected data and propose a hypothesis. Then, they have the opportunity to analyze the data to develop a conclusion about their research question.

SUGGESTED GRADE LEVELS

- 7 – 12

ENDURING UNDERSTANDINGS

- Accurate and reliable data must be analyzed impartially to develop conclusions.
- Technology has improved data collection for scientists.

OBJECTIVE

Students will:

- Read and understand an experimental design.
- Formulate a research question and propose a hypothesis.
- Use data to develop a conclusion.

ARIZONA DEPARTMENT OF EDUCATION STANDARDS

Grade	Science	Mathematics	Writing
7	S1-C1-01; S1-C2-02; S1-C3-01; S1-C3-02; S1-C3-03; S1-C3-04; S1-C3-05; S1-C3-06; S1-C3-07; S1-C4-01; S1-C4-02; S1-C4-03; S1-C4-05; S2-C1-04; S3-C1-01	S2-C1-03; S2-C1-04; S2-C1-07; S2-C1-08; S2-C1-09	S2-C1-01; S2-C1-03; S2-C1-04; S2-C2-03; S2-C2-05; S2-C3-02; S2-C3-04; S2-C4-01; S2-C4-03; S2-C5-02; S3-C2-01; S3-C2-03
8	S1-C1-01; S1-C1-03; S1-C2-02; S1-C3-01; S1-C3-02; S1-C3-04; S1-C3-05; S1-C3-08; S1-C4-01; S1-C4-02; S1-C4-03; S1-C4-05	S2-C1-03; S2-C1-07; S2-C1-08	

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Grade	Science	Mathematics	Writing
High School	S1-C1-01; S1-C1-02; S1-C1-03; S1-C3-01; S1-C3-02; S1-C3-07; S1-C4-01; S1-C4-02; S1-C4-03; S1-C4-04; S3-C1-01; S3-C1-03; S3-C1-05; S3-C2-05	S2-C1-02; S2-C1-08; S2-C1-09; S2-C1-11	S2-C1-03; S2-C1-05; S2-C2-03; S2-C2-05; S2-C3-02; S2-C3-03; S2-C4-01; S2-C4-02; S2-C4-03; S2-C5-03; S3-C2-01

Note: The full text of these standards can be found in Appendix A.

TIME FRAME

- Two days (45 minutes each day)

MATERIALS

- *Do Underpasses Really Work?* worksheet (one class set)
- *Experiment Planning and Comprehension* worksheet (one per student)
- *Analyzing the Data* worksheet (one per student)
- *Research Rubric* (one per student)
- Optional: Computers with Internet access

TEACHER PREPARATION

- Make a class set of copies of the *Do Underpasses Really Work?* worksheet.
- Make copies of the *Experiment Planning and Comprehension, Analyzing the Data* worksheets and the *Research Rubric* for each student.

SUGGESTED PROCEDURES

1. Hand out the *Do Underpasses Really Work?* worksheet.
2. Inform the students that the Arizona Game and Fish Department and the Arizona Department of Transportation have begun building underpasses to prevent wildlife-elk collisions. It is now the responsibility of the students to determine if these underpasses are successful.
3. Give the students time to read the worksheet.
4. Initiate a brief discussion of the worksheet. Point out that a lot of information was presented about what researchers are doing to study the underpasses. Now it is up to the students to come up with a research question that can be answered using the data collected by the researchers and propose a hypothesis.
5. Hand out the *Experiment Planning and Comprehension* worksheet.
6. Provide time for the students to answer the questions. If they do not finish, allow them to complete the worksheet for homework.
7. When the students have completed the worksheet, inform them that they will now have the opportunity to look at the data collected so far. Make it clear that they don't need to use all of the data on the worksheet. They should use only the information that is related to their question and hypothesis. When they are ready, they will prepare a formal scientific report in which they share the results of their experiment.
8. Hand out the *Analyzing the Data* worksheet and the *Research Rubric*.
9. Allow time for the students to prepare their reports using the rubric for guidance as they write.

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ASSESSMENT

- Scientific report

EXTENSIONS

- Have the students compare their results with the official results posted at the Arizona Game and Fish Web site and explain why there may or may not be differences.
- Students can develop visual displays of their experiment and the class can hold a poster session or similar scientific conference to present their results.

Appendix A: Arizona Department of Education Standards – Full Text

Science Standards

Grade	Strand	Concept	Performance Objective
7	1	1 – Observations, Questions, and Hypotheses	1 – Formulate questions based on observations that lead to the development of a hypothesis
		2 – Scientific Testing	2 – Design an investigation to test individual variables using scientific processes
		3 – Analysis and Conclusions	1 – Analyze data obtained in a scientific investigation to identify trends 2 – Form a logical argument about a correlation between variables or sequence of events 3 – Analyze results of data collection in order to accept or reject the hypothesis 4 – Determine the validity and reliability of results of an investigation 5 – Formulate a conclusion based on data analysis 6 – Refine hypotheses based on results from investigations 7 – Formulate new questions based on the results of a previous investigation
		4 – Communication	1 – Choose and appropriate graphic representation for collected data 2 – Display data collected from a controlled investigation 3 – Communicate the results of an investigation with appropriate use of qualitative and quantitative information 5 – Communicate the results and conclusion of the investigation
	2	1 – History of Science as a Human Endeavor	4 – Analyze the use of technology in science-related careers
	3	1 – Changes in Environments	1 – Analyze environmental risks caused by human interaction with biological or geological systems
8	1	1 – Observations, Questions, and Hypotheses	1 – Formulate questions based on observations that lead to the development of a hypothesis 3 – Generate a hypothesis that can be tested
		2 – Scientific Testing	2 – Design a controlled investigation to support or reject a hypothesis

Science Standards Continued

Grade	Strand	Concept	Performance Objective
8	1	3 – Analysis and Conclusions	1 – Analyze data obtained in a scientific investigation to identify trends 2 – Form a logical argument about a correlation between variables or sequence of events 4 – Formulate a future investigation based on the data collected 5 – Explain how evidence supports the validity and reliability of a conclusion 8 – Formulate new questions based on the results of a previous investigation
		4 – Communication	1 – Communicate the results of an investigation 2 – Choose an appropriate graphic representation for collected data 3 – Present analyses and conclusions in clear, concise formats 5 – Communicate the results and conclusion of the investigation
High School	1	1 – Observations, Questions, and Hypotheses	1 – Evaluate scientific information for relevance to a given problem 2 – Develop questions from observations that transition into testable hypotheses 3 – Formulate a testable hypothesis
		3 – Analysis, Conclusion, and Refinement	1 – Interpret data that show a variety of possible relationships between variables 2 – Evaluate whether investigational data support or do not support the proposed hypothesis 7 – Propose further investigations based on the findings of a conducted investigation
		4 – Communication	1 – For a specific investigation, choose an appropriate method for communicating the results 2 – Produce graphs that communicate data 3 – Communicate results clearly and logically 4 – Support conclusions with logical scientific arguments

Science Standards Continued

Grade	Strand	Concept	Performance Objective
High School	3	1 – Changes in Environments	1 – Evaluate how the processes of natural ecosystems affect, and are affected by, humans 3 – Assess how human activities can affect the potential for hazards 5 – Evaluate the effectiveness of conservation practices and preservation techniques on environmental quality and biodiversity
		2 – Science and Technology in Society	5 – Evaluate methods used to manage natural resources

Mathematics Standards

Grade	Strand	Concept	Performance Objective
7	2	1 – Data Analysis (Statistics)	3 – Determine when it is appropriate to use histograms, line graphs, double bar graphs, and stem-and-leaf plots 4 – Interpret data displays including histograms, stem-and-leaf plots, circle graphs, and double line graphs 7 – Interpret trends from displayed data 8 – Compare trends in data related to the same investigation 9 – Solve contextual problems using histograms, line graphs or continuous data, double bar graphs, and stem-and-leaf plots
8	2	1 – Data Analysis (Statistics)	3 – Determine the appropriate type of graphical display for a given data set 7 – Formulate reasonable predictions based on a given set of data 8 – Compare trends in data related to the same investigation
High School	2	1 – Data Analysis (Statistics)	2 – Organize collected data into an appropriate graphical representation 8 – Make reasonable predictions for a set of data, based on patterns 9 – Draw inferences from charts, tables, graphs, plots, or data sets 11 – Evaluate the reasonableness of conclusions drawn from data analysis

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Writing Standards

Grade	Strand	Concept	Performance Objective
7 – 8	2	1 – Ideas and Content	1 – Use clear, focused ideas and details to support the topic 3 – Develop a sufficient explanation or exploration of the topic 4 – Include ideas and details that show original perspective
		2 – Organization	3 – Place details appropriately to support the main idea 5 – Construct paragraphs by arranging sentences with an organizing principle (e.g., to develop a topic, to indicate a chronology)
		3 – Voice	2 – Convey a sense of identity through originality, sincerity, liveliness, or humor appropriate to the topic and type of writing 4 – Choose appropriate voice (e.g., formal, informal, academic discourse) for the audience and purpose
		4 – Word Choice	1 – Use accurate, specific, powerful words that effectively convey the intended message 3 – Use vocabulary that is original, varied, and natural
		5 – Sentence Fluency	2 – Create sentences that flow together and sound natural when read aloud
	3	2 – Expository	1 – Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic 3 – Write a process essay that includes: a. a thesis statement b. supporting details c. introductory, body, and concluding paragraphs
High School	2	1 – Ideas and Content	3 – Provide sufficient, relevant and carefully selected details for support 5 – Include ideas and details that show original perspective and insights
		2 – Organization	3 – Place details appropriately to support the main idea 5 – Employ a variety of paragraphing strategies (e.g., topical, chronological, spatial) appropriate to application and purpose

Writing Standards Continued

Grade	Strand	Concept	Performance Objective
High School	2	3 – Voice	2 – Convey a sense of identity through originality, sincerity, liveliness, or humor appropriate to the topic and type of writing 3 – Choose appropriate voice (e.g., formal, informal, academic discourse) for the application
		4 – Word Choice	1 – Use accurate, specific, powerful words and phrases that effectively convey the intended message 2 – Use vocabulary that is original, varied, and natural 3 – Use words that evoke clear images
		5 – Sentence Fluency	3 – Demonstrate a flow that is natural and powerful when read aloud
	3	2 – Expository	1 – Write a multi-paragraph essay that: a. includes background information to set up the thesis (hypothesis, essential question), as appropriate b. states a thesis with a narrow focus c. includes evidence in support of a thesis in the form of details, facts, examples, or reasons d. communicates information and ideas from primary and/or secondary sources accurately and coherently, as appropriate e. attributes sources of information as appropriate f. includes a topic sentence for each body paragraph g. includes relevant factors and variables that need to be considered h. Includes visual aids to organize and record information on charts, tables, maps, and graphs, as appropriate i. includes an effective conclusion

Appendix B: Worksheets and Overheads

The pages that follow contain the worksheets listed below:

A. *Do Underpasses Really Work?* – A summary of the experimental design for the highway underpasses along State Route 260 (3 pages)

B. *Experiment Planning and Comprehension* – A handout which helps the students determine questions that they can study (1 page)

C. *Analyzing the Data* – A summary of the actual data collected on wildlife usage of highway underpasses along State Route 260 (2 pages)

D. *Research Rubric* – One method to evaluate the student report (1 page)